Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 3

Friday 10 May 2019 (morning)

Candidate session number

1 hour

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[35 marks]**.

Section A	Questions
Answer all questions.	1 – 3

Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 6
Option B — Biotechnology and bioinformatics	7 – 9
Option C — Ecology and conservation	10 – 14
Option D — Human physiology	15 – 18

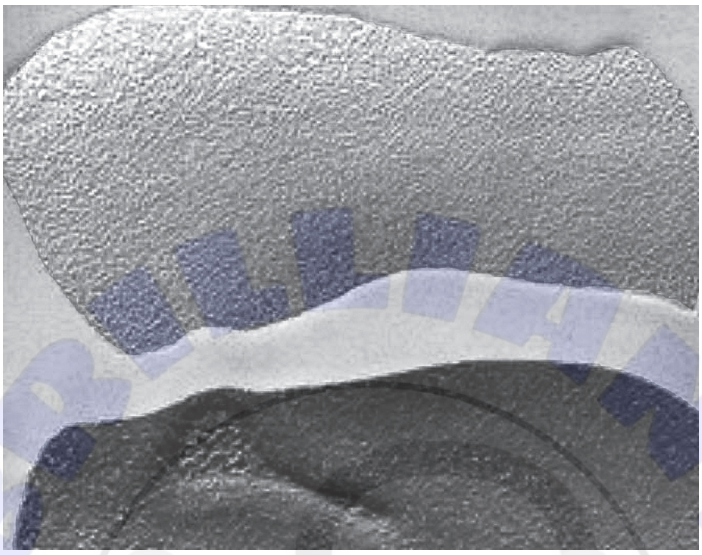
2219 – 6012

23 pages

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Membrane structure can be investigated using a technique known as freeze fracture. Cells are frozen and then split. Fracturing often occurs between the two phospholipid layers of membranes in the cell. An electron micrograph of such a fractured membrane is shown.



[Source: © Science Photo Library]

(a) Using the scale bar, calculate the magnification of the image. [2]

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(b) Explain how electron micrographs such as this helped to falsify the Davson–Danielli model of membrane structure. [2]

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(This question continues on the following page)

(Question 1 continued)

(c) Explain how the amphipathic nature of phospholipids allows them to form bilayers. [2]

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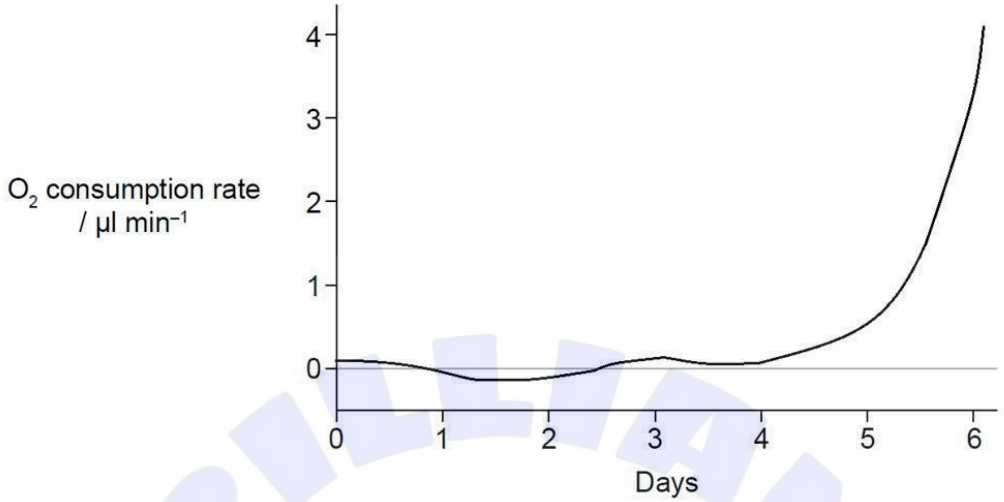
2. When feed for animals is stored, moisture levels need to be kept low to prevent the growth of fungi. Feed was exposed to 15 % moisture and placed into a respirometer. O_2 consumption was monitored using the respirometer over a period of six days.



[Source: © International Baccalaureate Organization 2019]

(a) (i) Outline how O_2 consumption is measured using a respirometer. [2]

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(ii) Suggest **one** conclusion that can be drawn from the results shown in the graph. [1]

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(iii) Other than humidity, suggest a variable that would need to be controlled in this experiment. [1]

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(This question continues on the following page)

(Question 2 continued)

(b) Outline the role of fungi in nutrient cycling. [2]

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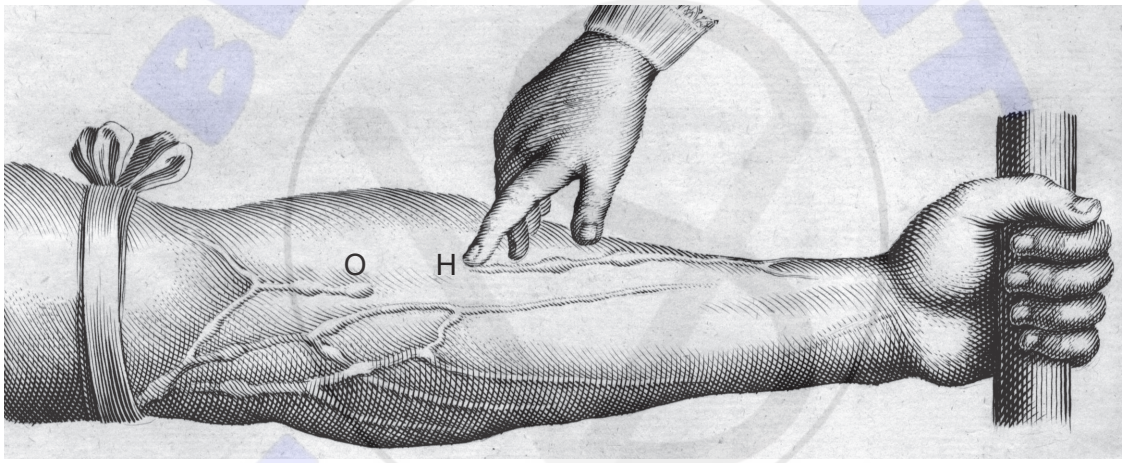
3. In 1628, the physician William Harvey described details of the circulation of blood for the first time. In one experiment, he tied a tight bandage around the upper arm of a volunteer to display the blood vessels in the lower arm more clearly. He pressed his finger on the blood vessel at H. At the same time, he pushed the blood in the vessel from H to O with a second finger, removing the blood as shown in the diagram. When the finger at H was released, the blood vessel refilled with blood.



[Source: adapted from William Harvey original plate]

(a) Identify the type of blood vessels shown in the diagram. [1]

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(b) Deduce what the experiment demonstrated about the circulation of blood. [2]

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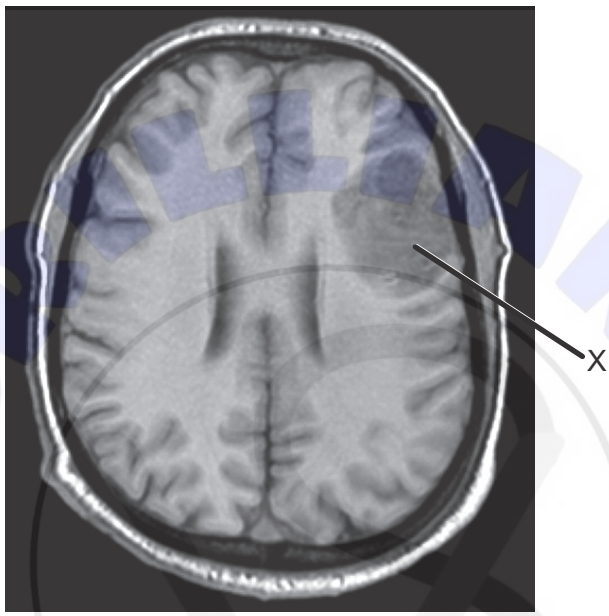
Section B

Answer **all** of the questions from **one** of the options. Answers must be written within the answer boxes provided.

Option A — Neurobiology and behaviour

4. The scan shows the brain of a patient affected by a stroke. The dark patch labelled X represents an area where cells have died.

Front of head



[Source: Case courtesy of Dr Ahmed Abdrabou, Radiopaedia.org, rID: 36865]

(a) State the name of the general area of the brain affected by this stroke. [1]

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(b) Explain how patient recovery from a stroke illustrates the property of neural plasticity. [2]

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(Option A continues on the following page)

(Option A, question 4 continued)

(c) Explain how studies of lesions have helped to identify the functions of different parts of the brain. [3]

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5. (a) Explain the neural control of swallowing. [3]

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(b) Neurons are initially produced by differentiation in the neural tube. Outline the mechanisms of axon and synapse development that follow the initial creation of neurons. [4]

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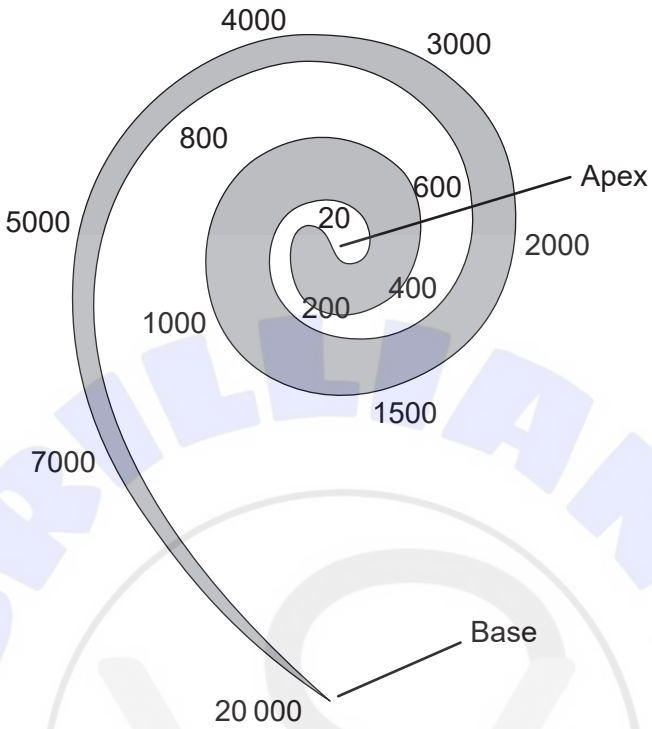
(Option A continues on the following page)

(Option A continued)

6. The diagram illustrates the sensitivity to sound frequencies, measured in Hz, of the different regions of the semicircular canal. The base is the region closest to the oval window.



[Source: © International Baccalaureate Organization 2019]

(a) Outline the relationship between the distance from the oval window and the sound frequency detected. [1]

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(b) State the range of sound frequencies detected by the ear. [1]

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(c) Sensory receptors are divided into different categories. Hair cells in the cochlea are sensory receptors. State the category to which they belong. [1]

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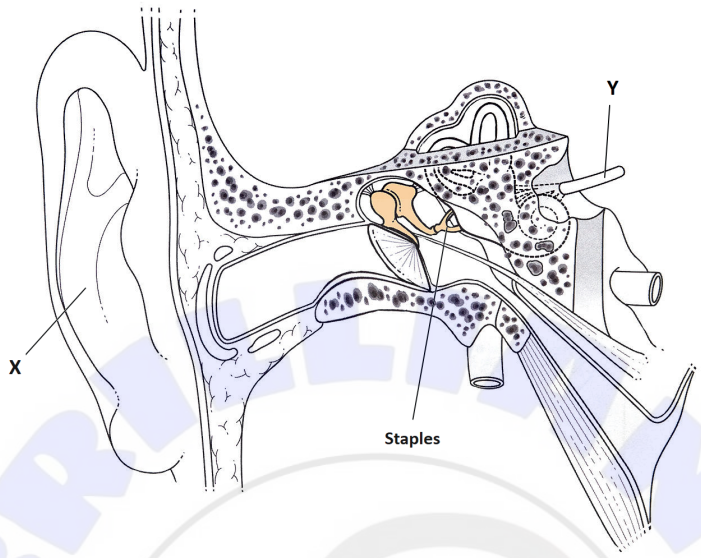
(Option A continues on the following page)

(Option A, question 6 continued)

(d) The diagram shows the human ear.



[Source: Didier Descouens, https://commons.wikimedia.org/wiki/Category:Human_middle_ear#/media/File:Place-des-osselets-Schema.jpg, licensed under CC BY-SA 3.0]

(i) Identify the structure labelled Y in the diagram. [1]

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(ii) Annotate the diagram with an X to show the internal location where a cochlear implant is placed. [1]

(e) Outline the function of the stapes. [2]

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End of Option A

Option B — Biotechnology and bioinformatics

7. Intensive livestock farming results in the production of organic wastes such as manure or slurry, which need to be treated before release to the environment. This waste can be used in the production of biogas.

In the covered lagoon system, water mixed with manure is stored for a period of time and the biogas is then collected. In the plug flow system, solid waste is pumped through a tank and the biogas is collected continuously. The two different systems were compared in terms of the rate of biogas production per 1000 cows on farms in California, USA.

Removed for copyright reasons

(a) Distinguish between the patterns of biogas generation by the two systems. [2]

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(Option B continues on the following page)

(Option B, question 7 continued)

(b) Suggest a reason that biogas production in the covered lagoon is lowest in the coldest months from December to February. [1]

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(c) State **one** environmental factor, other than temperature, that favours the activity of microbes in biogas production. [1]

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(d) Biogas contains hydrogen sulfide, which has an unpleasant odour. Bacteria from the genus *Thiobacillus* can convert the hydrogen sulfide gas to solid sulfur. Suggest how a trickle filter bed might be used to remove the hydrogen sulfide from biogas. [3]

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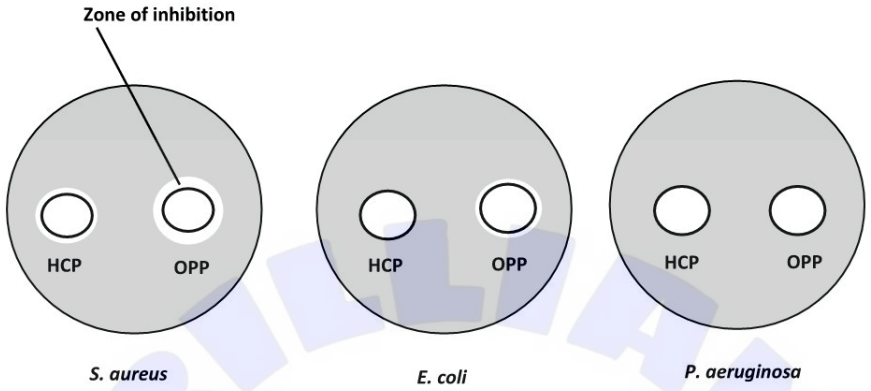
(Option B continues on the following page)

(Option B continued)

8. Hexochlorophene (HCP) and ortho-phenylphenol (OPP) are two ingredients of handwashing formulations. The antiseptic effectiveness of the two agents was tested by soaking discs in the agents and applying them to plates inoculated with *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. The resulting zones of inhibition are depicted.



[Source: © International Baccalaureate Organization 2019]

(a) Estimate the diameter of the zone of inhibition around the disc containing OPP in the *S. aureus* culture. [1]

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(b) *E. coli* and *P. aeruginosa* are both Gram-negative bacteria and *S. aureus* is Gram-positive. Explain how it could be verified that *S. aureus* is a Gram-positive bacterium. [2]

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(Option B continues on the following page)

(Option B, question 8 continued)

(c) The three species of bacteria are commonly found on skin. Explain why excessive handwashing with HCP might lead to a *P. aeruginosa* infection. [2]

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(d) *P. aeruginosa* is a concern in hospitals because it tends to form biofilms. Outline **one** reason for biofilms being particularly difficult to eradicate. [1]

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(Option B continues on the following page)

(Option B continued)

9. (a) Some bacterial genes are used as marker genes. Outline the use of marker genes in genetic modification. [3]

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(b) Outline the process of producing bulk quantities of hepatitis B vaccine in tobacco plants. [4]

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End of Option B

Option C — Ecology and conservation

10. Torre Guaceto is a marine protected area which covers over 22 km^2 of the Adriatic Sea in south-eastern Italy. The diagram shows a food chain within this area.

Seagrass (*Cymodocea nodosa*) → Sea urchin (*Paracentrotus lividus*) → Sea bream (*Sparus aurata*)

The data refers to the numbers of these three species inside the marine protected area, where fishing is limited, and outside the marine protected area, where fishing is allowed.

	Within the fully protected area	**Outside the fully protected area**
Sea bream individuals per 100 m^2	30	3
Sea urchin individuals per 100 m^2	70	690
% algae cover	47	15

[Source: data provided by The Science of Marine Reserves Project (PISCO), based on Guidetti 2006 Ecological Applications]

(a) State the trophic level of the sea urchin. [1]

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(b) Compare and contrast the community structure within and outside the marine protected area. [3]

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(Option C continues on the following page)

(Option C, question 10 continued)

(c) With respect to this food chain, outline what is meant by a keystone species. [3]

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(Option C continues on the following page)

(Option C continued)

11. The table shows the distribution of four coral reef species along a transect as a function of depth.

Depth / m	*Orbicella annularis*	*Agaricia tenuifolia*	*Porites divaricata*	*Siderastrea radians*
1.5				X
2.5	X			
6.5	X	X	X	
8.0		X	X	
9.0		X		

[Source: © International Baccalaureate Organization 2019]

(a) From the data, identify the depth along the transect where the greatest species richness is observed. [1]

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(b) Outline the relationship between *Zooxanthellae* and reef-building coral reef species. [2]

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(c) Suggest **one** way in which depth may act as a limiting factor for coral. [1]

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(Option C continues on the following page)

(Option C continued)

12. Outline **one** example of an active management strategy employed in the context of *in situ* conservation. [2]

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13. Outline **three** ways in which a **named** environmental disturbance can impact an ecosystem. [3]

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14. Explain what is meant by competitive exclusion, with respect to a **named** example of an invasive species. [4]

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End of Option C

Option D — Human physiology

15. (a) Osteomalacia is a condition that can be caused by Vitamin D deficiency. Outline **one** effect of osteomalacia. [1]

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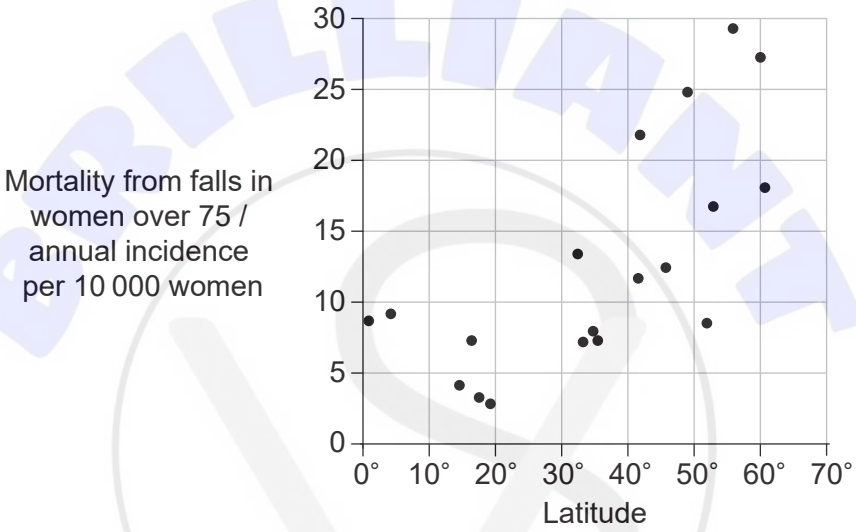
(b) Vitamin D is converted from an inactive form to an active form by exposure to sunlight. The graph shows the mortality (death rate) from falls in women over 75 as a function of latitude (distance from the equator).



[Source: Food and Agriculture Organization of the United Nations, 1997, B E C Nordin, Calcium in Health and Disease, www.fao.org/3/W7336T/w7336t04.htm#calcium%20in%20health%20and%20disease. Reproduced with permission]

(i) Outline the relationship shown in the graph. [1]

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(ii) Suggest reasons for this relationship. [2]

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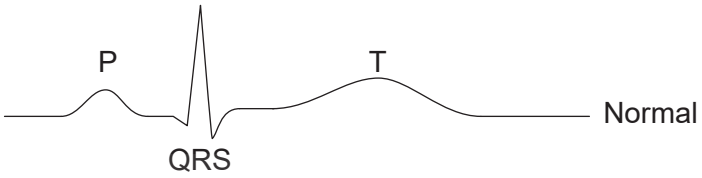
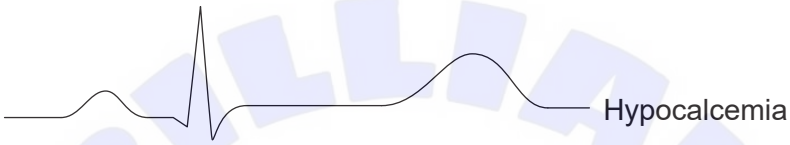
(Option D continues on the following page)

(Option D, question 15 continued)

(c) Vitamin D deficiency can cause low blood calcium concentrations (hypocalcemia). Very low blood calcium can have an impact on heart function. The first ECG is for a patient with normal blood calcium concentrations. The second ECG is for a patient who has very low blood calcium concentrations.





[Source: © International Baccalaureate Organization 2019]

(i) Compare and contrast the two ECG traces. [2]

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(ii) Outline **one** event that occurs in the heart during the T wave. [1]

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(Option D continues on the following page)

(Option D continued)

16. (a) Outline **one** consequence for the heart of the eating disorder anorexia nervosa. [1]

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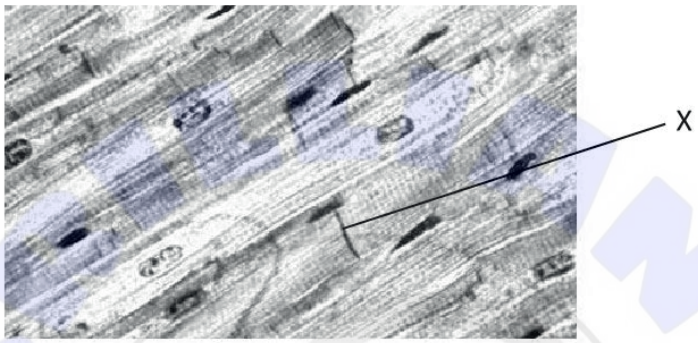
(b) The micrograph shows cardiac muscle.



[Source: https://commons.wikimedia.org/wiki/File:Musculocardiaco.jpg by Goyitrina, licensed Creative Commons Attribution-Share Alike 3.0]

The structure labelled X in the micrograph is a junction between two cardiac muscle cells. Identify the structure labelled X. [1]

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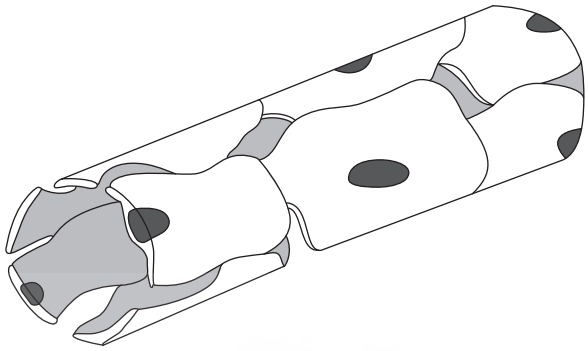
(Option D continues on the following page)

(Option D continued)

17. The diagram is of a liver sinusoid.



[Source: © International Baccalaureate Organization 2019]

(a) List the **two** blood vessels that supply the sinusoids. [2]

1. . . . . .

2. . . . . .

(b) State **one** feature in the diagram that identifies the structure as a sinusoid. [1]

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(c) Excess nutrients absorbed in the intestine can be stored. State **one** example of a nutrient stored in the liver. [1]

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(Option D continues on the following page)

(Option D continued)

18. (a) Hypochlorhydria is a condition whereby patients produce low quantities of stomach acid. Outline the effect this might have on the normal processes within the stomach. [3]

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(b) Explain the mechanisms that regulate the composition of gastric juices. [4]

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End of Option D

Please **do not** write on this page.

Answers written on this page
will not be marked.